Flight Test Activity for C-27J Civil Certification in Icing Conditions

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TOPICS

- Certification Approach
- Test Activity
  - Artificial ice shapes
  - Natural Ice
  - Severe Ice
- Lessons Learned Areas
  - Feasibility of flight testing with artificial ice shapes
  - Feasibility stall testing in natural ice
  - Severe ice cueing/alerting

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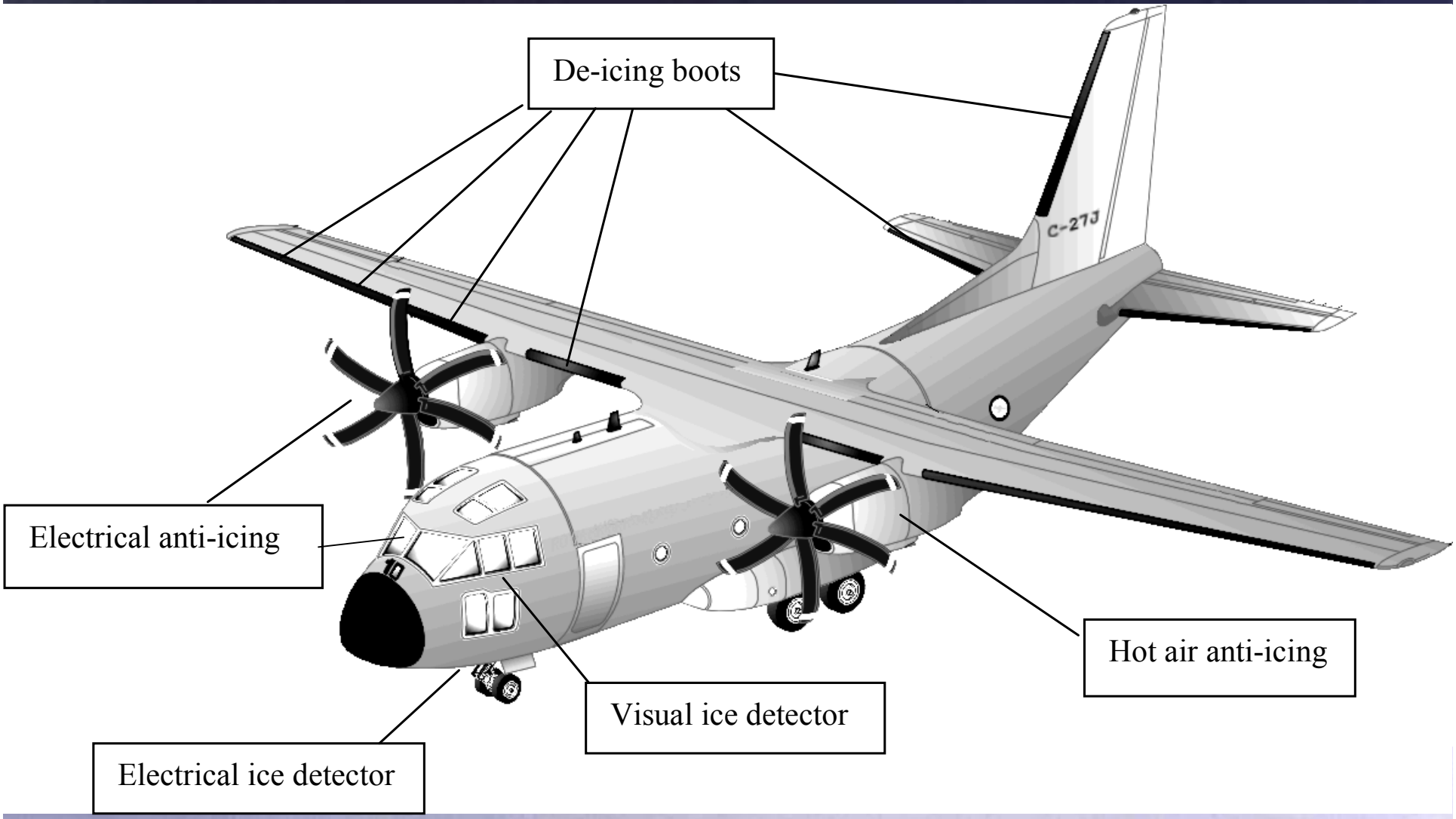
Certification Approach



Ice Protection Systems

Certification Approach

Up-to-date

Certification Requirements

JAR 25 Appendix C

F-08

JAA In

Icing conditions for stratiform and cumuliform clouds

Normal Icing Conditions

Assessment of

Performance and Handling Qualities

A/C Systems Capabilities

Pressure altitude

- Outside air temperature

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Certification Approach

CRI F-08 - NPA 25 F219

Compliance demonstrated by

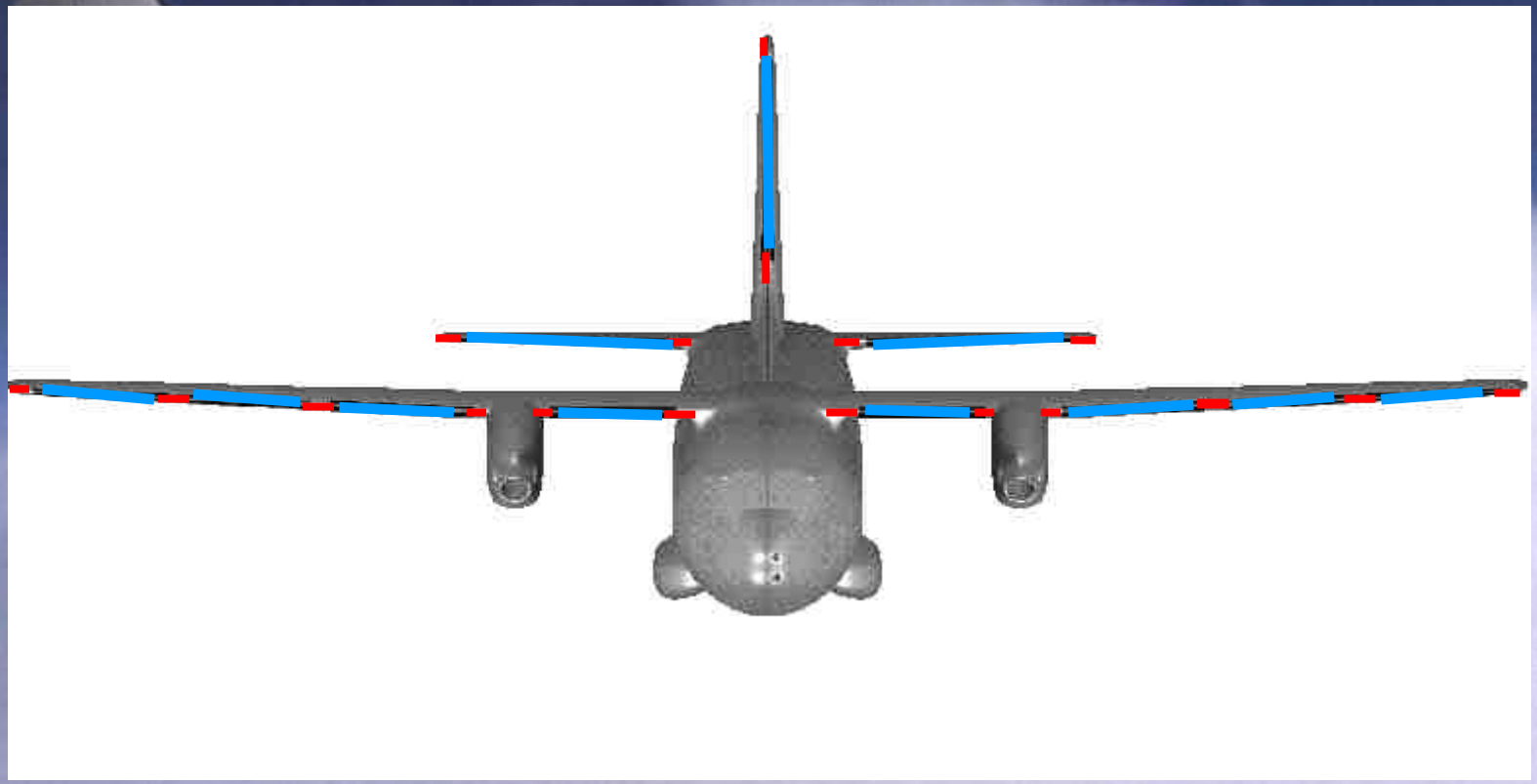
- *Numerical simulation*
  Demonstrating the existence of visual cues to warn the crew the aeroplane inadvertently entered Severe Icing conditions..
- *Wind tunnel testing*
  to preliminary verify the impact of “Quarter Round/One Inch High/Flat Side Forward” ice shape on lateral controllability of the a/c before performing flight tests
- *Flight Tests*
  Performed with shape located on both wings for longitudinal control and on one wing for lateral control assessment.
  Autopilot disengagement when the a/c entering severe icing conditions was satisfactory verified.
- *AFM* contains limitations to be observed while exiting Severe Icing

SPARTAN
330

C-27J

Test Activity: Artificial Ice shapes

Ice shapes tested by a build-up procedure



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FLIGHT CAMPAIGN IN DRY AIR

11 different ice shapes configurations

26 Flights

39 hours of flight

486 flight test points

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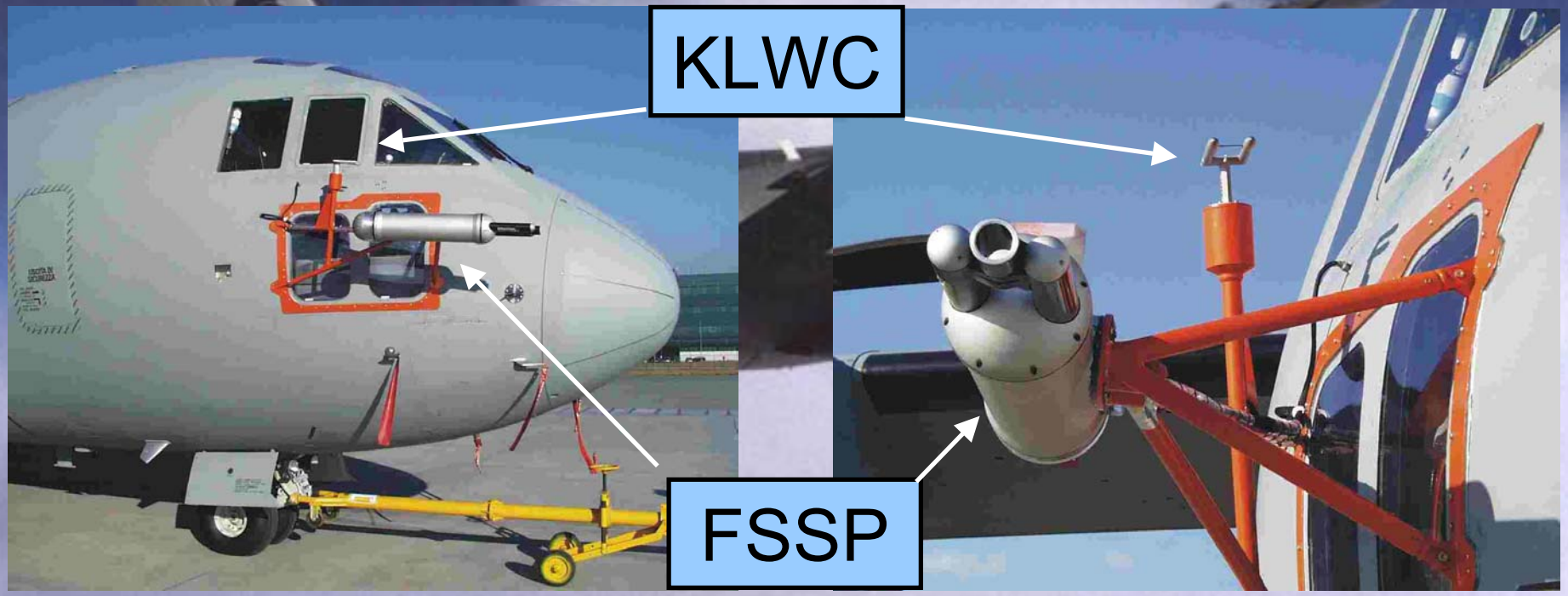
T INSTRUM
-27J Civil Certification i

Test Activity: Natural ice

PROBES for atmospheric measurement



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FLIGHT CAMPAIGN IN NATURAL ICE

16 Flights

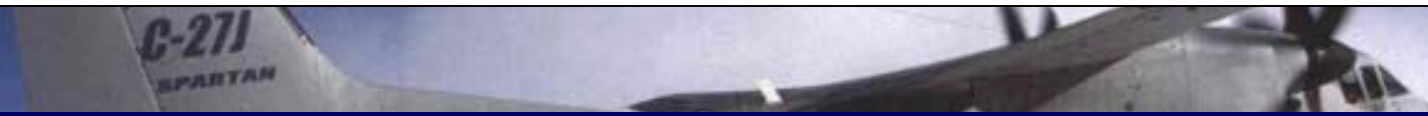
54 hours of flight

25 flight test points repeated in different ice conditions

Test Activity: Severe Ice

Severe icing conditions

Means to the crew to determine when the aeroplane has inadvertently entered Severe Icing Conditions



Results obtained on similar aircraft

computational simulation tools

test in natural ice

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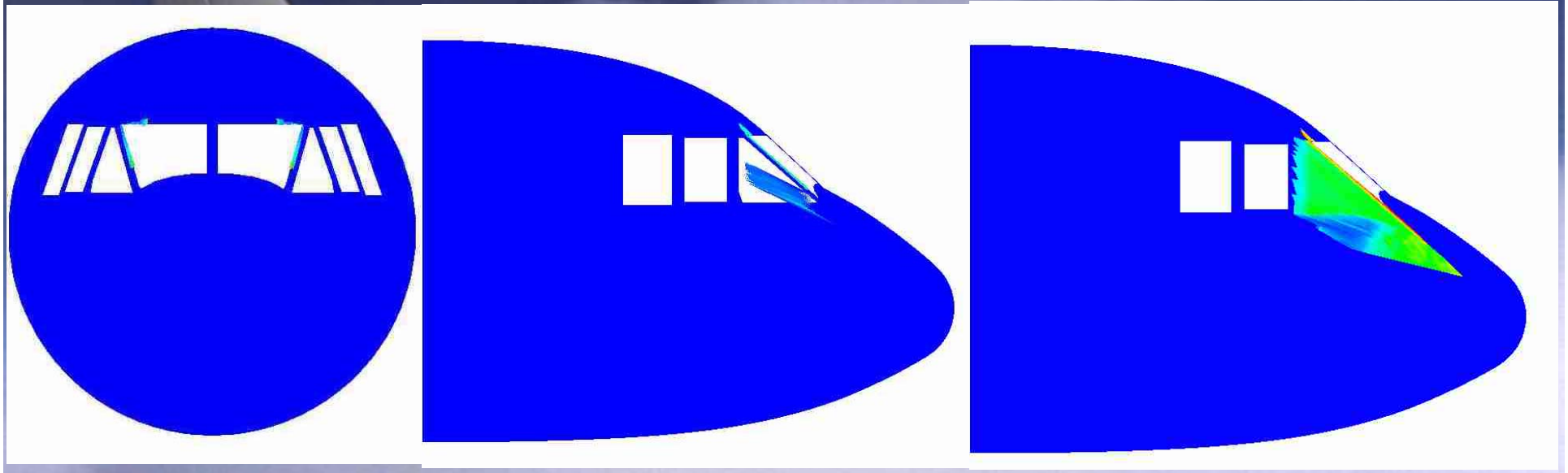
Test Activity: Severe Ice

Visual cues for severe icing conditions



50 μm

90 μm

150 μm

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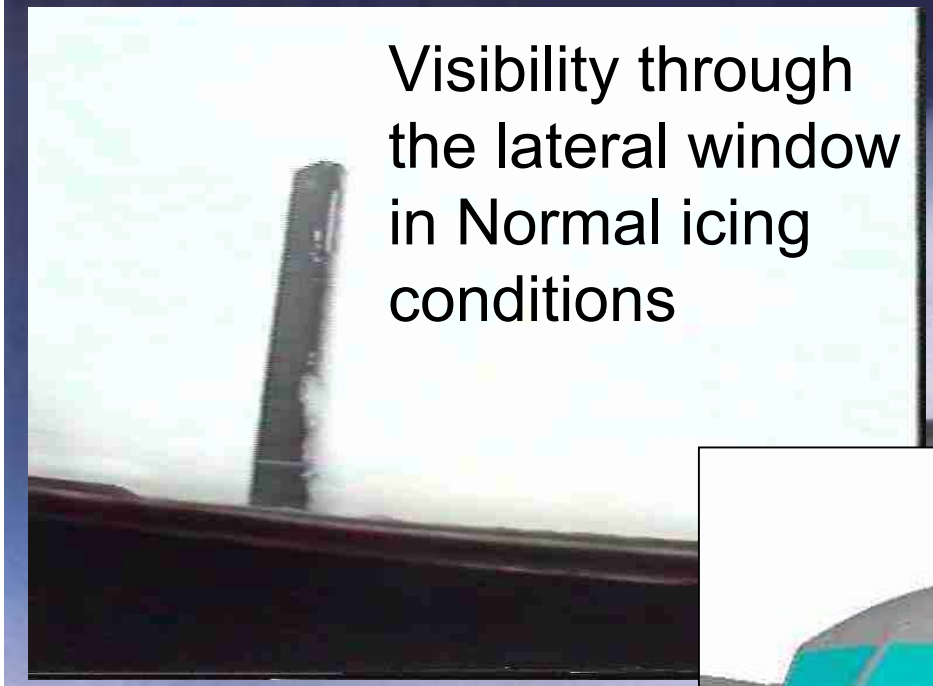
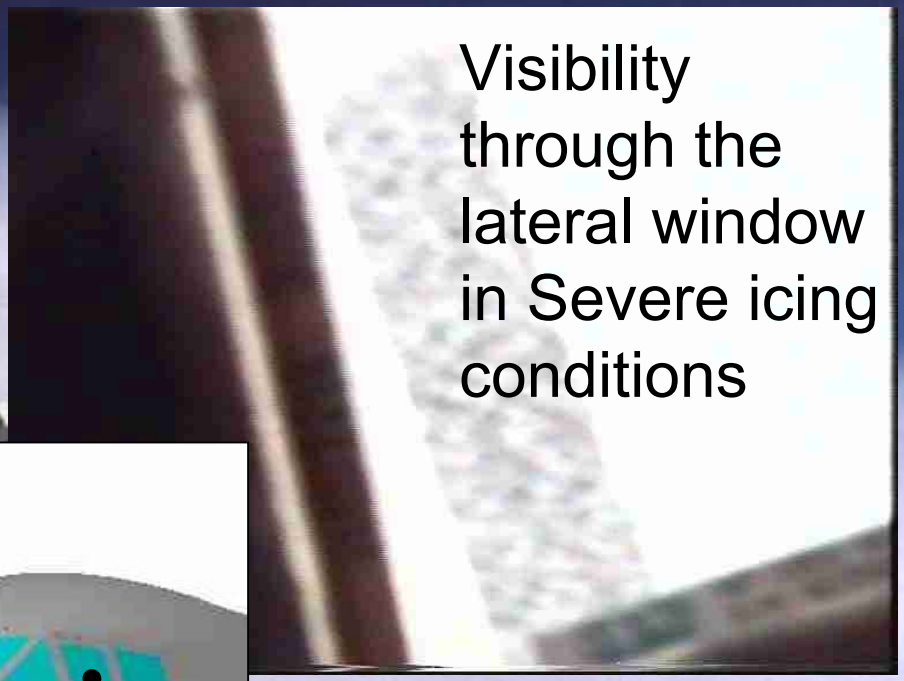
Test Activity: Severe Ice

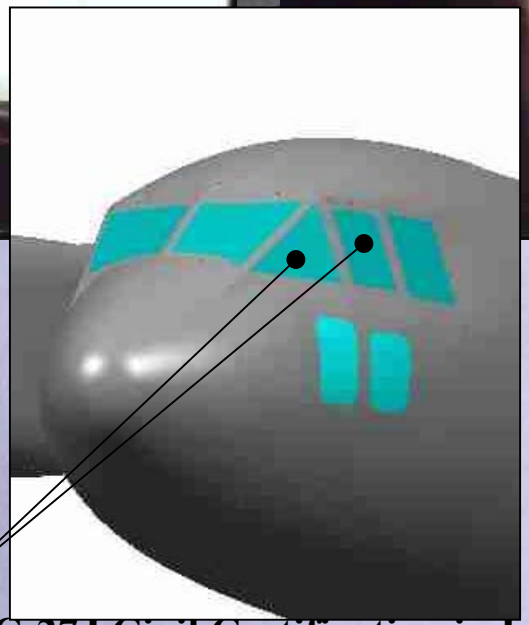
Visual cues for severe icing conditions



Visibility through the lateral window in Normal icing conditions



Visibility through the lateral window in Severe icing conditions



Ice accretions experienced during encounters with droplet larger than 50 microns

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Test Activity: Severe Ice

Severe icing conditions

Assessment of the design to ensure that the aeroplane can safely exit from severe icing conditions

Computational analyses

Test in wind tunnel

Flight test with artificial ice shapes

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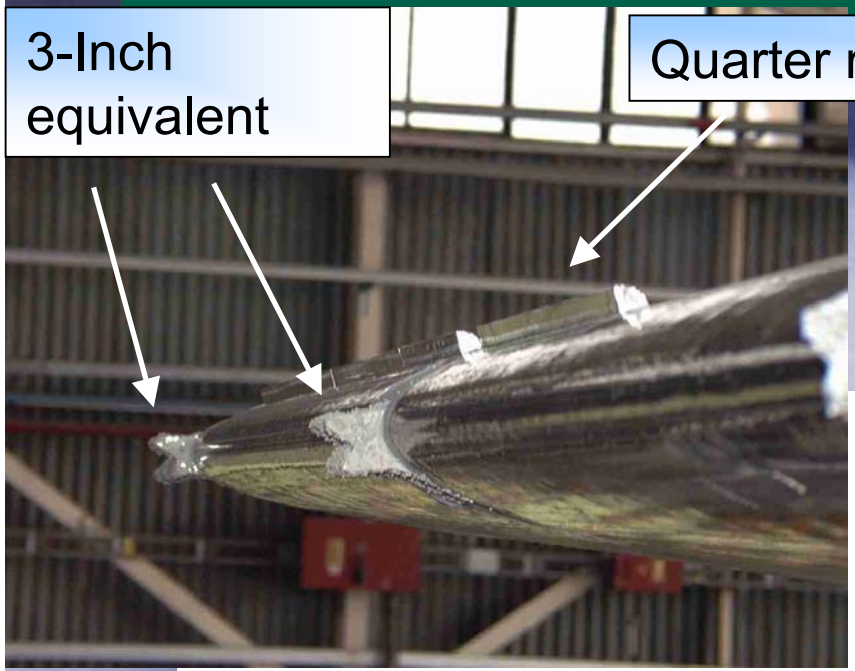
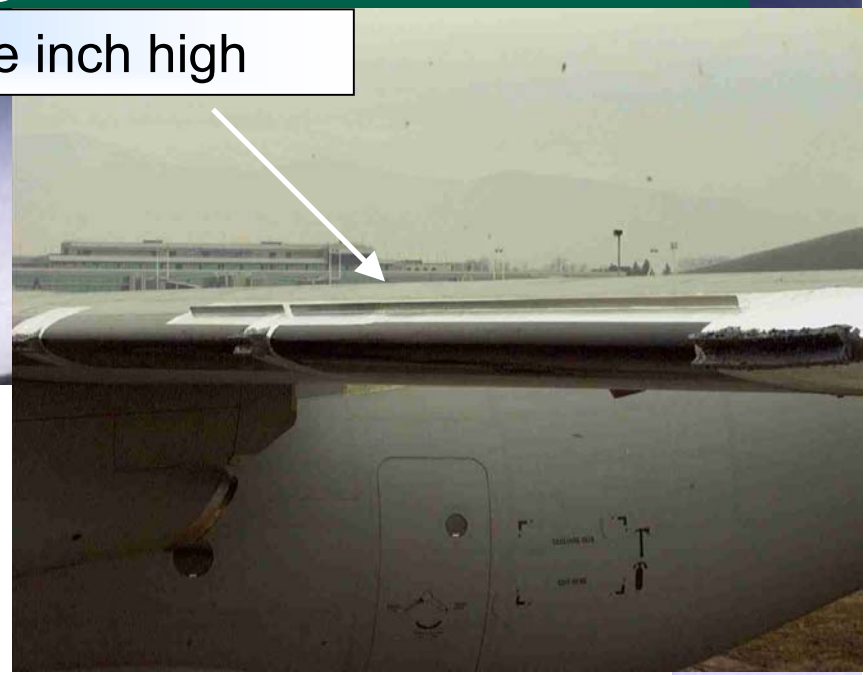
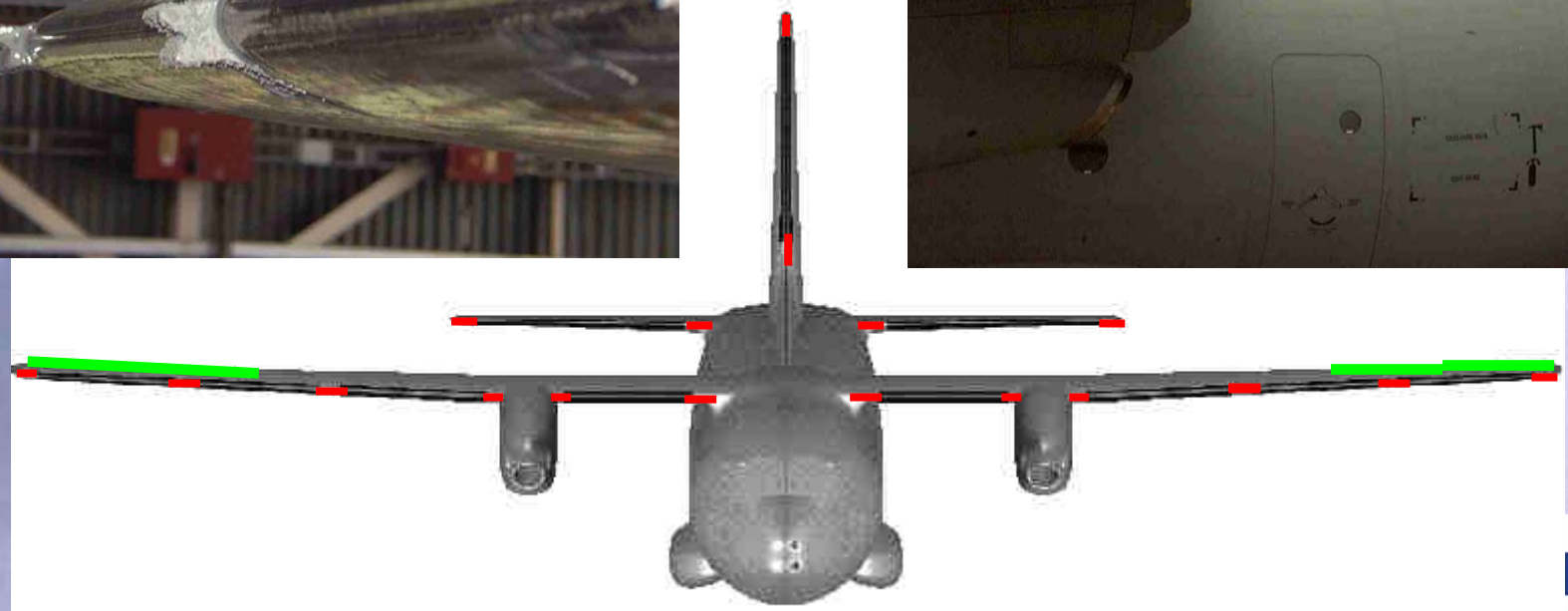
Test Activity: Severe Ice

Flight tests to show the capability to exit from severe icing conditions







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FLIGHT CAMPAIGN IN SIMULATED SEVERE ICE

3 different ice shapes configurations

6 Flights

7 hours of flight

131 flight test points

visual cues validated in natural ice

The C-27J can safely exit inadvertent severe icing also with the A/P disengaged and engaged

Test in heavy weight configurations with artificial ice shape

CONSIDERATIONS

The result was a very onerous activity in terms of planning, flying, costs, time and resources.

This high price could probably be reduced by more extensive use of analytical methods (es: cross reading the aircraft behaviour at light weight versus heavy weight with/without ice shapes) which in our application gave the same results then actual tests performed at heavy weight.

Flight test safety issues should be part of the complex process of writing Airworthiness requirement and its interpretative material.

Stall warning margin evaluation in Natural Ice

CONSIDERATIONS

- The very stringent requirements for dry air campaign with **"validated" ice shapes** should be sufficient to have full confidence on stall warning margin reliability.

  Also in this case the results obtained by actual stalls in natural ice just confirmed those demonstrated with artificial ice shapes in clear air.

- Natural ice campaign should then be carried out **just to validate the ice shapes, to assess systems efficiency** and spot check handling qualities and performance characteristic with those observed with ice shapes.

- **Stall Warning margin tests in natural ice could not be necessary**

Visual cues for severe icing conditions

Considerations

JAA INT/POL/25/11 well underline the importance of the detection phase and the definition of visual cues to safely exit severe icing conditions.
Their verification is a demanding activity and not always successful. In addition the encounters with Severe Icing conditions are rare and inherently dangerous events.

The effort required in this kind of testing and the uncertainty of the results, stress the need to research a new type and more reliable ice detector suitable to be installed on commercial airplanes at reasonable costs.

Questions

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